

DEPARTMENT OF TRANSPORTATION
ENGINEERING SERVICE CENTER
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METHOD FOR DETERMINING ASPHALT DURABILITY USING THE CALIFORNIA TILT-OVEN DURABILITY TEST

CAUTION: Prior to handling test materials, performing equipment setups, and/or conducting this method, testers are required to read "**SAFETY AND HEALTH**" in Section F of this method. It is the responsibility of the user of this method to consult and use departmental safety and health practices and determine the applicability of regulatory limitations before any testing is performed.

A. SCOPE

This method utilizes the apparatus required for AASHTO Designation: T 240 (Rolling Thin Film Test) with slight modifications for two different methods. Method A - ages asphalt at 111°C for 168 h. These conditions simulate the effect of field weathering for two years at a hot desert site. Method B - ages asphalt at 113°C for 72 h. These conditions simulate the effect of four years of desert aging and correlate with the aging in the Pressure Aging Vessel (PAV), AASHTO Designation: PP1, at 110°C. There are also some procedural differences between these methods.

This test method refers to the following other test methods: AASHTO Designation: T 49, T 51, T 202 and California Test 381.

B. APPARATUS¹

1. Oven: This shall be a double-walled, electrically heated, convection type. Its inside dimensions are approximately: height 380 mm, width 485 mm, and depth (with door closed) 445 ± 13 mm. The door shall contain a symmetrically located window with dimensions of 305 to 330 mm wide by 203 to 230 mm high. The window shall contain two sheets of heat-resistant glass separated by an air space. The window should permit an unobstructed view of the interior of the oven.

The top of the upper heating element shall be 25 ± 3 mm below the oven's floor. The oven shall be vented top and bottom. The bottom vents shall be located symmetrically to supply incoming air around the heating elements. They shall have an open area of 1500 ± 70 mm². The top vents shall be symmetrically arranged in the upper part of the oven and have an open area of 930 ± 45 mm².

The oven shall have an air plenum covering the side walls and ceiling; the air space being 38 ± 4.8 mm deep from the walls and ceiling. At a midpoint in the width of the oven and approximately 152 mm from the face of the circular metal carriage to its axis, a squirrel cage-type fan, 133 mm O.D. by 73 mm wide shall be turned at 180 rad/s by an externally mounted motor. The squirrel cage fan shall be set so that the fan turns in an opposite direction to its vanes. The airflow characteristics of the fan-plenum system shall be suction from the floor of the oven through the wall plenums and exiting of the air through the fan. Figures 1 and 2 show details of this plenum system.

The oven shall be equipped with a proportional control thermostat capable of maintaining $111 \pm 0.5^\circ\text{C}$ (Method A) or $113 \pm 0.5^\circ\text{C}$ (Method B). The sensing element of the thermostat shall be placed approximately 25 mm from the left side and approximately 38 mm from the ceiling of the

¹ Complete equipment may be obtained from James Cox & Sons, Inc., Colfax, California.

interior of the plenum enclosed oven so that the end of the sensing element is at a point approximately 203 mm from the rear interior wall of the oven. The thermometer shall be positioned through a cork stopper into the right vent hole (facing the door, Figure 1) in the top of the oven so that the end of the thermometer touches the plenum. The thermometer exits the cork stopper at approximately 95°C so that it can be easily read. The heating controls shall be capable of bringing the fully loaded oven back to the test temperature within a 10-min period after insertion of the samples into a preheated oven.

The oven shall be provided with a 305 ± 3 mm diameter vertical circular carriage (see Figure 2 for details). This carriage shall be provided with suitable openings and clips for firmly holding eight glass containers (see Figure 3) in a horizontal position. The vertical carriage shall be mechanically driven through a 19-mm diameter shaft rotated at 1.57 ± 0.02 rad/s.

2. Thermometer: Range, 70 to 120°C; length 305 mm; gradation, 0.2°C divisions; total immersion.

A thermometer for the "Distillation of Benzol and Toluol" from VWR Scientific, Inc., Catalog VWR 61088-005 meets these specifications.

3. Container: The container in which the sample is to be tested shall be of heat-resistant glass conforming to the dimensions shown in Figure 3.

C. PREPARATION OF OVEN

1. Position the thermometer as indicated previously and illustrated in Figure 1.
2. Level and tilt the oven so that the horizontal axis of the glass containers is tilted 1.06° (approximately 10 mm rise in 540 mm) higher in the front (door opening) of the oven when in position in the carriage.

Leveling may be accomplished as follows:

- a. Place the oven on a stiff board (thick plywood or metal).

- b. Level the oven as described below using a straight glass sample container as a leveling bubble:

- (1) Fill the bottle with approximately 35 mL of water or light oil.
 - (2) Lay the bottle on its side on a known level surface.
 - (3) Mark on each end of the bottle the position of the fluid in the bottle when level.
 - (4) Place the bottle in a rack of the oven.
 - (5) Level the oven by shimming under the board so that the fluid in the bottle is in a level position according to the marks. Rotate the rack to different positions so that the best level position is attained for the oven.
3. Tilt the oven by inserting a 10 mm spacer on the board under the oven 540 mm from the back edge of the bottom of the oven.

NOTE: Rolling Thin Film Ovens utilize regulated air. Be sure this supply is shut off for the Tilt-Oven Durability Test.

D. PROCEDURE

METHOD A

1. Preheat the oven for a minimum of 16 h prior to testing with the controls on the setting that will be used during the operation of the oven. The control thermostat shall be adjusted so that when the oven is fully loaded and the air is on, it will maintain $111 \pm 0.5^\circ\text{C}$.
2. The sample as received shall be free of water. Heat the sample in its container with a loosely fitted cover in an oven not to exceed 163°C for the minimum time necessary to ensure that the sample is completely fluid. Manually stir the sample, but avoid incorporating air bubbles.
3. Pour 35 ± 0.5 g of the sample into each of the required number of glass containers, providing sufficient material for all the tests that are to be run on the residue.

NOTE: A minimum of two test bottles will be required per sample if only the Penetration, Viscosity at 60°C, and Ductility are performed. Pour and perform the Penetration initially, then reheat to pour the Viscosity and Ductility test specimens. Cool to room temperature.

4. With the oven at operating temperature, arrange the containers holding the asphalt in the carriage so that the carriage is balanced. Fill any unused spaces in the carriage with empty containers. Close the door and rotate the carriage assembly at a rate of 1.57 ± 0.02 rad/s. Maintain the samples in the oven with the circulating fan on and the carriage rotating for $168 \text{ h} \pm 10 \text{ min}$. The test temperature, $111^\circ\text{C} \pm 0.5^\circ\text{C}$, should be reached within the first 10 min. At the conclusion of the testing period, remove the containers from the oven.
5. Immediately place the containers, in an upright (vertical) position, in an oven at $163 \pm 3^\circ\text{C}$ for 20 to 30 min. Remove and pour all of the residue, without scraping, into a metal container and cover if no tests are performed immediately.

NOTE: Normally, all testing of the residue should be completed within 72 h.

METHOD B

1. Preheat the oven for a minimum of 16 h prior to testing with the controls on the setting, which will be used during the operation of the oven. The control thermostat shall be adjusted so that when the oven is fully loaded and the fan is on, it will maintain $113 \pm 0.5^\circ\text{C}$.
2. The sample is preconditioned by aging in the Rolling Thin Film Oven per AASHTO Designation: T 240. The bottle is transferred to the Tilt-Oven with or without cooling to room temperature.

Only one bottle will be required per sample for testing in the Dynamic Shear Rheometer.

3. With the oven at the operating temperature, arrange the containers holding the asphalt in the carriage so that the carriage is balanced. Fill any unused spaces in the carriage with

empty containers. Close the door and rotate the carriage assembly at a rate of 1.57 ± 0.02 rad/s. Maintain the samples in the oven with the circulating fan on and the carriage rotating for $72 \text{ h} \pm 10 \text{ min}$. The test temperature should be reached within the first 10 min. At the conclusion of the testing period, remove the containers from the oven.

4. Immediately place the containers, in an upright (vertical) position, in an oven at $163 \pm 3^\circ\text{C}$ for 20 to 30 min. Remove all of the residue (scraping is allowed) into a metal container and cover if no tests are performed immediately.

E. TESTING

Residue from aging by Method A is tested by Penetration at 25°C (AASHTO Designation: T 49), Absolute Viscosity at 60°C (AASHTO Designation: T 202), and Ductility at 25°C (AASHTO Designation: T 51).

Residue from aging by Method B is tested by Dynamic Shear Rheometer at 25°C (California Test 381).

F. SAFETY AND HEALTH

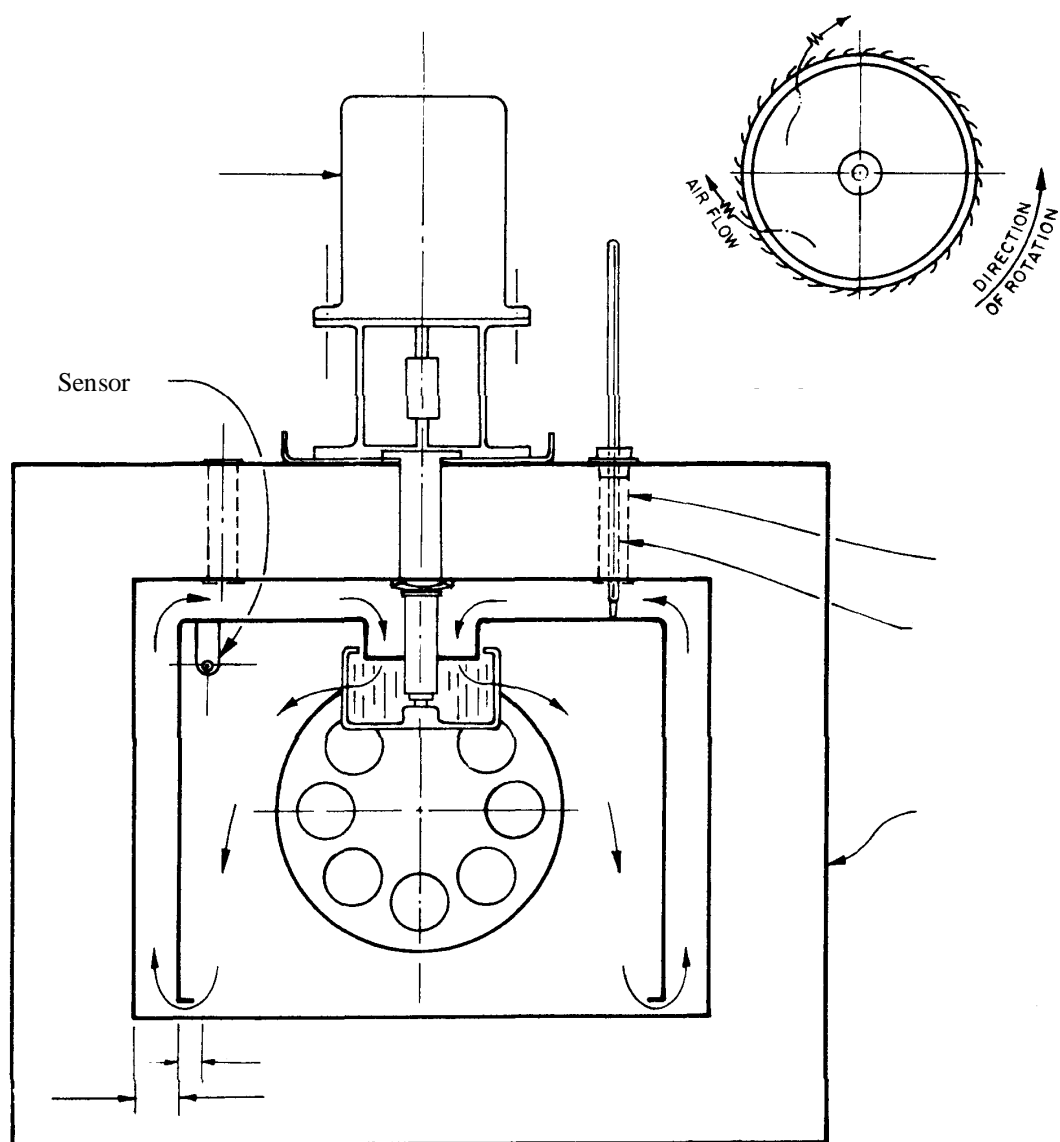
This test involves the handling of hot materials, objects and tools. Use proper gloves and handling equipment to prevent burns.

Prior to handling, testing or disposing of any waste materials, testers are required to read: Part A (Section 5.0), Part B (Sections: 5.0, 6.0 and 10.0) and Part C (Section 1.0) of Caltrans Laboratory Safety Manual. Users of this method do so at their own risk.

REFERENCES:

AASHTO Designations: T 240, PP1, T 49, T 51 and T 202
ASTM Designation: D 2872
California Test 381

End of Text (California Test 374 contains 7 pages)



Front View

FIGURE 1 - SCHEMATIC OF AIRFLOW

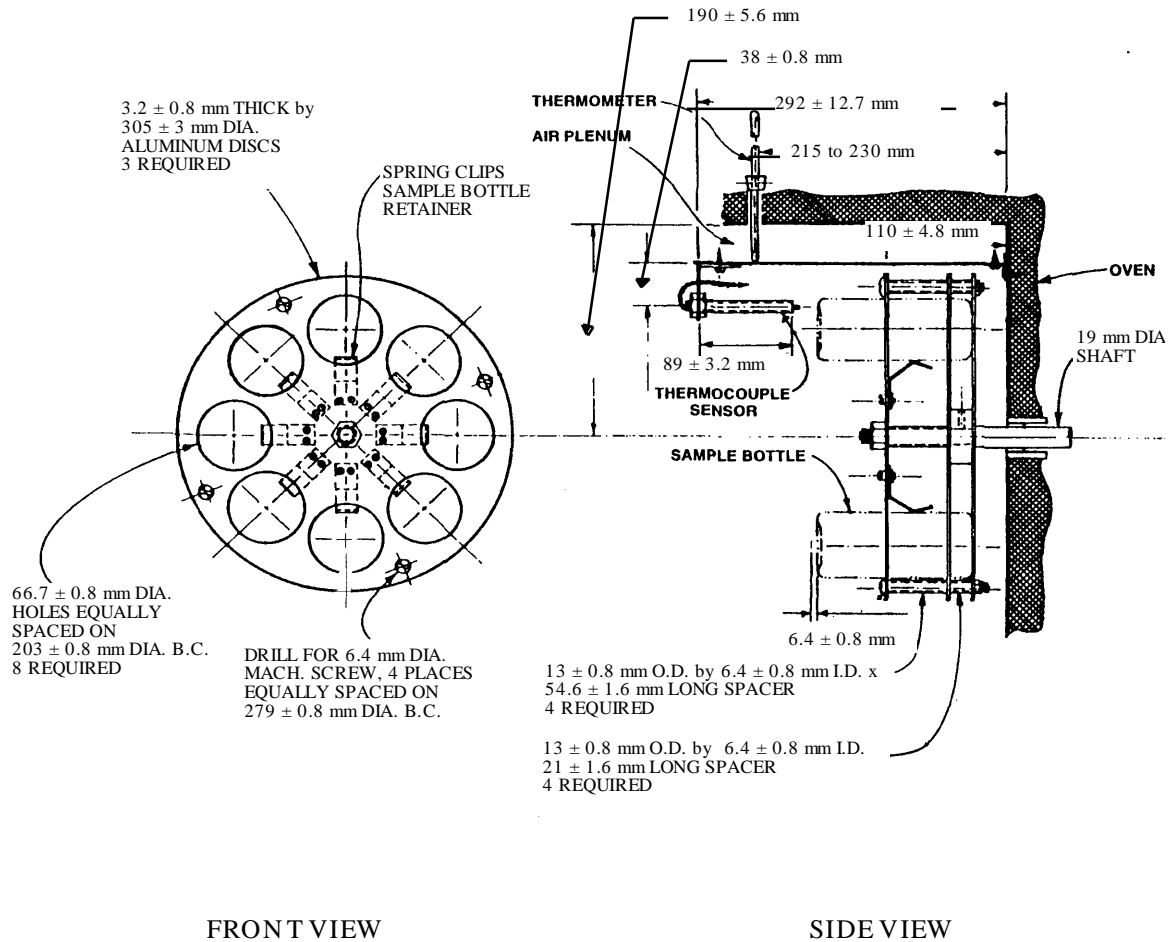


FIGURE 2 - CIRCULAR METAL CARRIAGE

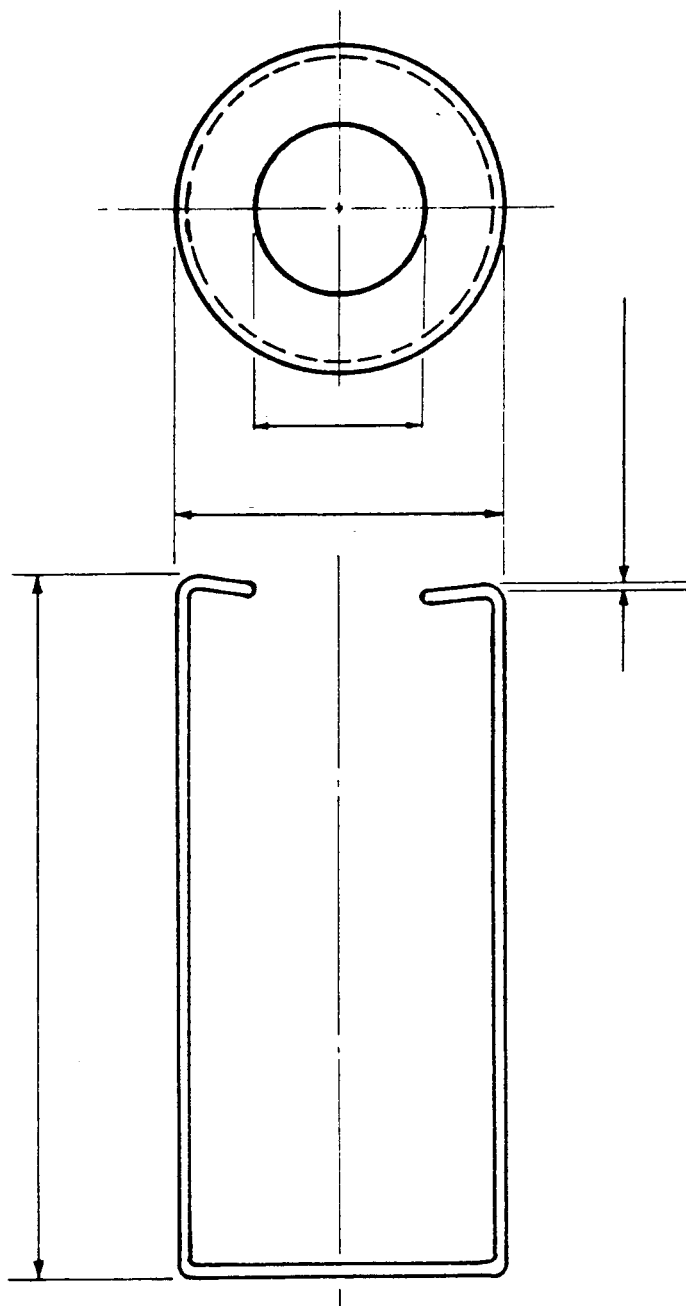


FIGURE 3 - SAMPLE BOTTLE